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ABSTRACT

A research project was conducted by Des Moines Area Community College (DMACC) to investigate the computer-based education (CBE) needs of DMACC, design a CBE system to meet those needs, provide a plan for implementing that system, and justify implementation costs. The project report begins by discussing initial planning activities, including efforts to define the areas of emphasis for the study and to identify the logistical problems in executing project activities. The report then examines DMACC's mission and goals, the current use of computers at the college, and the instructional problem areas that, in the opinion of the interviewed faculty members, could be ameliorated by a CBE system. The five goals for the CBE system developed on the basis of this needs assessment were: to provide alternative modes of delivery for instruction and testing; to facilitate cognitive mapping and other tools of educational analysis; to improve the instructional experiences of students; to provide staff development in the area of CBE; and to achieve computer literacy among students and staff. The report then details the recommended plan for implementing the system; projects the costs and analyzes the expected qualitative and quantitative benefits of the proposed system; and presents the recommendations of the project team. A chart delineating activities and time frames for CBE implementation is provided. (JP)

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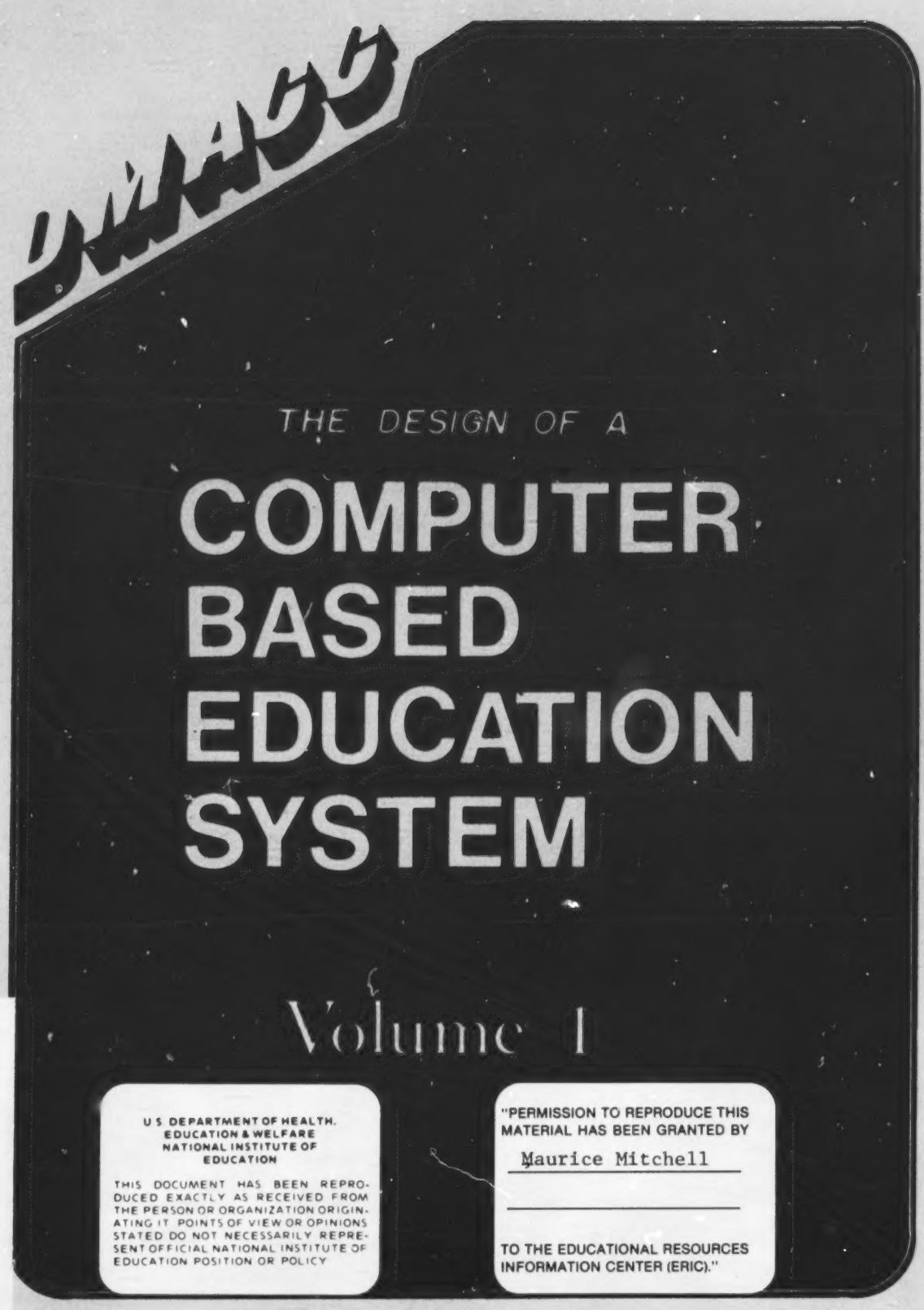

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The Design Of A
Computer Based Education System
for the
Des Moines Area Community College

A report to

Carroll Bennett

Vice President, Instruction

by the staff of the

Application Transfer Team Study

June, 1980

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PREFACE & ACKNOWLEDGEMENTS

The Des Moines Area Community College finds itself on the threshold of a new instructional era. After a vital infancy in the 1960's and a diseased, nearly fatal adolescence in the 1970's, computer based education (CBE) has emerged in the early 1980's as a healthy alternative form of instructional delivery. Educators now understand that CBE is not the panacea that early proponents forecast. However, persistant advocates have now demonstrated the value of the computer as an instructional tool and through a program of research and development have demonstrated a large variety of appropriate applications in the instructional process.

This report marks the proper, systems approach to the implementation of computer based education at DMACC. The report documents the refinement of the problem of "if" and "how" the college should proceed with the application of CBE. It documents the analysis of the CBE needs unique to DMACC and the resultant system design. Finally, after the DMACC CBE System was designed, a plan was developed for implementing the system. Pertinent costs for the implementation and operation of the system were projected as well as the tangible and intangible benefits of such a system.

The most important aspect of this project effort is that, with the implementation of this new instructional technology, the Des Moines Area Community College will be better able to offer instructional services to its constituency and to better insure that its students successfully accomplish their college goals.

A large number of people contributed to the success of this project. Their contributions deserve recognition: Carroll Bennett, for initiating the effort and providing continuous support to the project staff; the faculty of all the divisions and campuses of the college for their sincere and willing input, especially those faculty who were formally interviewed; Sue Leslie, Glenn Reinemund, and Luella Webb, the specialists contributed by IBM, whose counsel and day-to-day participation greatly aided the project staff; the staff of the Word Processing Center, the college Copy Service, and the graphics and office staff of Media Services; and finally, the project staff, Ted Clinkenbeard, Bob Jansen, Terri Phares, Jack Zeller, and Gary Wilcox, who unselfishly and professionally spent more than 1500 person-hours in the day-to-day activities of the project and preparing this report.

Maurice Mitchell
Project Manager
June, 1980

TABLE OF CONTENTS

Volume I

			Page
Acknowledgements			i
List of Tables			iii
List of Figures			iv
Glossary			v
Section	I.	Introduction	1
	II.	Planning Session	5
	III.	Needs Analysis	8
	IV.	Architectural Overview & Module Definition	13
	V.	Implementation Plan	16
	VI.	Cost and Benefit Analysis	22
	VII.	Recommendations	33
	VIII.	Summary	35

Volume II

Appendix	A.	ATT Study Proposal
	B.	Planning Session — 2/28/80
	C.	Needs Analysis Interviews
	D.	Raw Data--Problems, Benefits, Cycles and Volumes
	E.	Computer Based Education System Architecture & Module Weighting and Prioritization Schedule
	F.	First Executive Review -- 4/3/80
	G.	Reference Visits
	H.	Courseware Search
	I.	Position Description--Director, Computer Based Education
	J.	General Architecture of the On-Line Student Data Base for the Comprehensive Learning Center
	K.	Final Executive Review -- 5/13/80
	L.	Letters of Endorsement

LIST OF TABLES

Volume I

Table		Page
V-1.	High Priority Modules Not In Implementation Matrix	16
V-2.	Terminal Use Calculation	17
VI-1.	Summary Costs	22
VI-2.	Instructional Courseware Costs	23
VI-3.	Non-Instructional Courseware Costs	24
VI-4.	Administrative Costs	25
VI-5.	Hardware/Software Costs	26
VI-6.	Income From Reduced Attrition	30
VI-7.	Return on Investment	31

Volume II

D-1.	Income and Expenditures per Contact Hour for FY'79	

Glossary

1. Authoring. The process of developing the content of a computer based instructional module.
2. Coding. The process of translating course materials into the computer language.
3. Cognitive Mapping. Determination of learning style, learning profile, or learning modality.
4. Collegiate Skills. Those skills needed by a student to function at college, i.e., study skills, library usage skills, etc.
5. Computer Based Education. All forms of educational computing including computer-assisted instruction, simulation, computer managed instruction and career data processing education.
6. Course. A unit of instruction for which x credits are given.
7. Courseware. Instructional programs for computer based education.
8. Developmental Skills. Those skills needed by a student to enter an academic area or meet a personal goal (i.e., basic math skills).
9. Formative Evaluation. Used to improve or modify.
10. Hardware. Physical equipment--such as electronic, magnetic, and mechanical devices.
11. IBM 370/158, 4331, 4341 Systems. Large computer systems which provide various magnitudes of processing and storage of information. The computers with which the CBE terminals may communicate.
12. IIS (Interactive Instructional System). A software package which provides many services and features for computer based instruction.
13. Job/Life Skills. Those skills needed by a student to move into a life area, i.e., resume writing, interviewing techniques, etc.
14. Module. A computer assisted unit of instruction which may be an entire course or a part of a course.
15. Software. Programs, procedures, and routines associated with the operation of a computer system.
16. Transportability. The ability to be used by more than one program/department/division.

SECTION I. INTRODUCTION

Background

Nearly two years ago, after mounting concern regarding computer services to the Des Moines Area Community College, the college joined in the Western Iowa Regional EDP Consortium (WIREC) which was to provide improved computer services to its members through a shared IBM 370/158 computer at Kirkwood Community College, Cedar Rapids. The immediate concern of the Consortium members was to provide timely management information and data processing as a part of their administrative functions, as well as Career Education Data Processing programming. To improve its computer services, the Des Moines Area Community College gained membership in WIREC.

The newly forming Consortium, intended to serve the western portion of Iowa, planned a state educational computer network in cooperation with a proposed eastern educational computer consortium. The plan called for two power sources (host computers). The initial power source is installed at the Kirkwood Community College in Cedar Rapids. A future, second power source is planned to be located in central Iowa, probably at the Des Moines Area Community College.

As the consortium planning and implementation activities have moved forward, progress has been made with the support of administrative systems and the support of Career Education Data Processing. The Consortium members have been able to redirect some of their planning toward future statewide computer services to non-data processing instructional issues.

CBE at DMACC

In the Summer of 1979 the Des Moines Area Community College began to take an in-depth look at Computer Based Education in light of this new and promising computer service. During the final year of the Advanced Institutional Development Project (AIDP) study of computer based education was made and some preliminary computer based education system design thoughts were expressed. With this initial expression of interest serving as a springboard, along with an immediate expression of interest by the Vice President for Business Management and the newly hired Director of Data Systems, the question of computer based education at the Des Moines Area Community College moved from a question of "if" to a question of "how and when".

In late Spring, 1979, a two day planning session was held with the assistance of IBM. This planning session resulted in a broadly defined set of action plans for instructional computer services and curriculum development. As a consequence of that planning session, Carroll Bennett, Vice President of Instruction, asked a subcommittee of the Curriculum and Instruction Committee and a task force chaired by Gary Wilcox, Dean of Arts and Sciences, to begin an in-depth investigation of the climate for the development of a computer based education system at the Des Moines Area Community College.

To support the investigation, five staff members from instruction attended an IBM instructional authoring workshop at the University of Akron in Ohio. This activity, cosponsored by Instruction and Business & Management, gave key staff members an in-depth look at a computer assisted instruction facility and in-depth exposure to the development of computer based instructional materials.

Initiation of the Project

In January of this year, Carroll Bennett, after assessing the input of the subcommittee of the Curriculum and Instruction Committee studying CBE and the Wilcox task force, felt that the time had come to mount a major design activity which would describe the optimum computer based education system for the Des Moines Area Community College.

In early February, following an IBM proposal for a study format (see Appendix A), Carroll Bennett named six members of the instructional staff to design the system. According to the agreement reached with IBM, the project would last approximately 12 weeks beginning in late Fegruary, would require the half-time attention of at least five DMACC persons, and would be supported by the half time contribution of two local IBM specialists, and on-site assistance for the full twelve weeks of an IBM Education Application Specialist from IBM's Bethseda based Education Industry Group.

Named as the project staff from the Des Moines Area Community College were: Ted Clinkenbeard, Math Instructor; Bob Jansen, CLC Instructor; Terri Phares, Data Processing Instructor; Jack Zeller, Accounting Instructor; and Maurice Mitchell, Director of Instructional Development, who was appointed as project manager. Gary Wilcox, Dean of Arts & Sciences, was designated to serve in a part-time capacity as the liaison from the administrative component of the instructional division. IBM Corporation assigned Sue Leslie, an education industry application specialist schooled in the application transfer team methodology; Glen Reinemund, Marketing Representative; and Luella Webb, Systems Engineer. These nine people, then, constituted the project staff.

Goal of the Project

The project began formally on February 28, 1980, with one major purpose. That goal was to file a report with Carroll Bennett, Vice President of Instruction which:

* reflected our investigation of DMACC computer based education needs;
* presented a computer based education system design which reflected these needs;

* contained a plan for implementing the computer based education system;
* and presented justification for the costs incurred in implementing the proposed computer based education system.

This report document fulfills that goal. The balance of the report will be organized in essentially the same manner as the activities of the project.

Plan of the Report

Section II describes the Application Transfer Team (ATT) planning session and its result. The collection and analysis of needs information is presented in Section III. Section IV describes the architecture of the computer based education system which we recommend be adopted. Section IV also includes a description and definition of the initial modules of the CBE system. Section V details the recommended plan for implementing the Computer Based Education System. Costs and benefits of the proposed CBE system are presented and discussed in Section VI. Section VII contains the recommendations of the project team. The final Section, VIII, contains a summary of the project activities, findings, and recommendations.

Since the appendixes, or supporting documents, for the information contained in this report are rather extensive, the appendixes have been bound as a separate volume. If the reader wishes to refer to any of the appendixes and does not have Volume 2 of this report, he or she may obtain a copy of Volume 2 from the project manager, Maurice Mitchell, Director of Instructional Development.

Executive Reviews

While these two volumes constitute the written comprehensive report of the project activities and the recommendation of the study team, there were two oral reports presented to Carroll Bennett. An interim executive review was held on April 6, 1980. Copies of the review agenda, handouts, and facsimiles of the overhead transparencies used during the course of the presentation are in Appendix F. When the formal information gathering, system design, and implementation plan activities were completed, a second executive review was held for Carroll Bennett. On May 13, 1980, a preliminary, oral version of this final report was presented. Copies of the agenda, those attending, handouts and facsimiles of the overhead transparencies are contained in Appendix K.

CBE and Data Processing Education

Throughout the report you will see references to Career Education Data Processing computer based education, and other curricular functions in data processing education such as programming training and operations training. Some of the data processing education instruction is included in the Computer Based Education System design recommended here. As a matter of fact, it constitutes a major portion of the system at this point. However, an attempt was made to separate those issues which reduce to Career Education direct costs and those which should be supported as an institutional service and thus an indirect cost. While we

recognize that the distinction we are making between Career Education Data Processing computer based education and other Data Processing instruction is a fine one, we hope that it will become clearer as we move through the report.

The following, then, details the activities of the project staff and the recommendations of the study team of the DMACC Instructional Personnel.

SECTION II. PLANNING SESSION

The first formal project activity in the development of a computer based education system for the Des Moines Area Community College was a one day planning session which was held on February 28, 1980. The session dealt with three issues: The definition of the areas of emphasis for the study; the delineation of objectives and guidelines for the CBE system; and, the identification and solution of the logistical problems in executing the project activities and preparing this final report. The agenda, list of participants, and documentation of the results of the session are included in Appendix B.

While the earlier two day planning session in late Spring, 1979, had identified a number of broad areas for instructional computer service and curriculum development, this project was intended to cover one narrow issue. To insure that the effort was concentrated in a narrow topic, the group at the planning session defined both the scope and the areas of emphasis for the study.

Scope

The scope of the project was declared to be: TO DESIGN THE OPTIMUM UTILIZATION OF COMPUTER BASED EDUCATION in the DMACC instruction.

Areas of Emphasis

To further delineate the task, the following areas of emphasis were defined:

* skills (job, developmental, collegiate, and placement skills);
* the alternate delivery of instructional modules and testing;
* tools for educational analysis;
* staff development;
* and, computer literacy for both staff and students.

(Some of the terms used in the previous sentence have special connotation for this project and are defined in the glossary at the front of this document).

Objectives

To aid in shaping the computer based education system which served those Areas of Emphasis, the following objectives were set out before the study began.

* To design a system characterized by quality, efficiency, consistency, and transportability.
* To enhance and extend DMACC program and course offerings both on and off campus.

* To focus the design on instruction in Career Education, Adult & Continuing Education, and Arts & Sciences.
* To train faculty in the use and development of Computer Based Education.

These objectives are more clearly explicated in Section IV of this report which deals with the design and system architecture which evolved during the study. In addition, two more objectives were declared for the study.

* To recommend subsequent area(s) for study following the conclusion of this project.
* Since this was DMACC's first experience with the particular process, to evaluate the application transfer team (ATT) methodology which was employed as the project management strategy.

Design Criteria

While the above objectives defined the general nature of the computer based education system, a number of design criteria were specified to insure that the system would be compatible and complementary with the other facets of the college. It was the desire of those at the planning session that certain of the college's services and other features be accessible from the CBE system and that the system have certain characteristics.

* To identify curriculum areas in the Areas of Emphasis which have a CBE need.
* To determine the most appropriate subject areas or modules for initial implementation in terms of:
  - time required to implement
  - return on investment (including intangibles)
  - positive climate and faculty interest
  - high probability of success
* To structure the design such that computer literacy modules could form the basis for a core requirement in the college's programs.
* To determine the desired/required data which should be collected by the system and to explore tools which could be used to analyze this data.
* To insure that the system interfaces with:
  - guidance and career exploration
  - the existing data base of student academic records
* To make policy recommendations on administrative organization of the CBE system.

When these "blueprints" (the scope, areas of emphasis, objectives, and design criteria) for the project were completed, the logistical issues for the project were addressed. The writing assignments were the first issue settled under logistics. A hypothetical outline of a final report was used as a guide and each section of the report was assigned to one of the DMACC project staff members. The instroduction, cost-benefit analysis, and recommendations were assigned to Maurice Mitchell. The needs analysis and its outcomes, the problems and concerns issues, were assigned to Jack Zeller and Bob Jansen, respectively. The systems architecture was assigned to Terri Phares and the implementation plan

was assigned to Ted Clinkenbeard. Because of the consultive nature of their project activities, the IBM personnel were not involved in the writing assignments.

The final issue settled at the planning session was the choice of a date for the final executive review (which would mark the end of congregated project activities). The date of Monday, May 12, 1980, was chosen as the day for the executive review. This was later changed to Tuesday, May 13, 1980.

SECTION III. NEEDS ANALYSIS

Organization

The Des Moines Area Community College is a multi-campus institution serving an eleven county area in Central Iowa. A map of the area is included in Appendix C. There are three major instructional divisions providing courses at four campuses and over a hundred other sites.

Mission of the Instructional Division

The goal of the Des Moines Area Community College is to provide an education to a broad base of society to meet a variety of needs. Specifically, the various divisions have the following goals:

* Career Education: To provide the vocational and technical education necessary for individuals who wish to enter the labor force to obtain productive employment.

* Arts & Sciences: To provide programs of study for the first two years of a college degree and to provide various programs in various paraprofessional areas, such as Law and Human Services.

* Adult & Continuing Education: To provide educational opportunities to individuals who are already employed who want to upgrade their training or receive training in other areas. Also, the division offers programs in high school completion and personal enrichment.

In order to meet the above objectives, the people (Appendix C) interviewed indicated many needs which a computer based education system could service. These needs relate to the objectives of each of the divisions.

Career Education. The use of a computer, either directly or indirectly, has become an integral part of many jobs and this usage is expected to grow rapidly. One study has predicted that more than 90% of all jobs by the year 2000 will involve interface with a computer system. It is, therefore, obvious that students preparing to enter the work force must have direct exposure to using a computer or they will not be adequately trained to meet their employer's needs.

Arts & Sciences. The computer is a useful tool in various aspects of research and development. During a four-year college education, students will be required to perform research studies in the physical and social sciences. The analysis of the results can most often be best done by a computer and, in some cases, only by a computer. The college

student, therefore, needs an early exposure to various computer based systems and techniques such as SPSS (Statistical Package for the Social Sciences), linear programming and linear regression in order to compete successfully in college.

Adult Education. Many people currently in the work force have never been exposed to a computer. As computers become an integral part of a company's system, these people stand to lose their jobs unless they upgrade their skills. The adult education division can provide a necessary service to the community by making available the courses needed for upgrading computer skills.

Current Use of Computers in Instruction

Currently, several types and pieces of computer hardware are used at DMACC for educational purposes. An IBM 360 Model 30 is used by the Career Education Data Processing instructional department. This computer is used to compile COBOL, FORTRAN, RPG, PL/1 and BAL programs written by students. It is also used for computer operations instruction.

The college also has 15 cathode ray tube (CRT) terminals connected to an IBM 370 Model 158 located at Cedar Rapids and used by a number of other schools in the WIREC Consortium. These terminals are also used for compiling programs in the languages listed above as well as BASIC.

The college has a Hewlett-Packard mini-computer used mainly by the math department. This computer has a plotter attached to it and is used to prepare graphs and other data requiring plotting of points. The Electronics Technology program has a number of mini- and micro-processors used for instruction of electronic circuitry. The Data Processing and Accounting departments have two Apple micro-processors which are to be used in educating students in the operation and programming of small computers.

In order to meet the objectives of each of these divisions at a reasonable cost, it is best that an overall plan for computer based education be adopted. There are many different methods of bringing computer based education to Des Moines Area Community College. This can be done by each division and department having small computers or being tied-in to a larger host computer, or, by a combination of these. The important thing is that some formal system be designed to meet the multi-faceted needs of such a diverse organization so that every area can meet its objectives.

Method of Identification of Problems and Needs

Various faculty members were interviewed to determine those areas where problems existed. The faculty members were selected for interviews in such a manner as to have all divisions and campuses represented. The specific members selected were chosen based on an expressed interest to provide input or by the committee's determination that they were in an area where CBE could possibly be of benefit. In all, 51 faculty members were interviewed. A list of those faculty who were interviewed is in Appendix C.

The committee broke into two teams, with at least two members of each team being DMACC personnel. The interviews were unstructured but the team had a pre-determined set of objectives to be achieved from each interview and conducted each interview session in a manner to achieve those objectives. A general guideline as to conducting an interview was developed and is included in Appendix C.

After the interviews were completed, the team members reviewed their notes and wrote up a summary of the interview. A copy of the summary was sent to each interviewee for review and correction. The corrected copy of each of the summaries is included in this report. (Appendix C.)

The team members identified areas of faculty interest and concerns where CBE could be an effective problem solution and these areas of concern became the basis for the recommendations of the committee.

Compilation and Categorization

A logical step for expanding computer based education was to identify the concerns and needs of the institution. As reported in the previous section, because of the diversity of potential input sources and wide range of possible users for the computer based education system, a series of interviews was set up with a number of faculty. The purpose of these interviews was to attain a comprehensive view of the existing informal system and to identify additional areas of emphasis where computer based education could be potentially beneficial to the institution. The concerns and needs compiled as a result of the interview process are summarized below (the raw data, problems and concerns, are listed in Appendix D):

Skills. There is a concern that students exiting from some curricular areas have not been exposed to all employment-related technology necessary for obtaining and/or keeping a job. For instance:

* Students in the Auto Parts Program need training in computerized inventory control.
* Automotive students need a firm understanding of microprocessor technology.
* Data processing students need the following skills or types of learning experiences:
  - simulation/experience on a variety of operating systems
  - key-to-disk data entry
  - on-line programming
  - compilations with a 1-hour turnaround time
  - training on PASCAL, CICS, IMS
  - DP equipment which reflects current industry trends
* Electronics technician students need to learn a high level programming language.
* Secretarial students need hands-on training on computer terminals and/or word processing equipment.
* Many faculty express a real concern that their skill or curriculum areas are changing so rapidly that it has become extremely difficult to stay current.

There is concern that entering students do not have the academic skills necessary to compete successfully in the classroom.

* Many students have insufficient skills in math and reading to compete effectively in some programs.
* Related instruction or general education components do not occur early enough in some programs.
* Many career education students need an introduction to research methods.

* Too few students have sufficient DMACC library usage skills and orientation.
* Many students, particularly foreign, have difficulty with "word" problems in math and the sciences.
* Because of the nature of their particular program, it is difficult to place Arts & Sciences students correctly in courses.

Alternate Delivery of Instructional Modules and Testing. Many instructors would like greater flexibility in course length, instructional strategies, and test administration.

* The distance many students, or prospective students, must travel to receive instruction on campus affects attendance and enrollment.
* Many faculty expressed a need for alternative instructional delivery modes which would provide greater instructional flexibility.
* There is a need for instruction packaged in small college credits units (i.e., 1 quarter-hour) which can:
  - be chained together to create more comprehensive programming
  - be used as "short courses"
  - be used to meet individual needs
* Test bank questions must be secure. They should be accessible only through the consent of the faculty member charged with their maintenance.
* Learning Center faculty would like the flexibility of working with small groups of students instead of individuals only.
* Faculty members do not currently have time available to administer and score challenge tests quickly.
* Certain staff members hold that there is a need for computer managed instruction (CMI) for basic skills instruction and computer assisted instruction (CAI) in some higher-level content areas.
* Due to new college programs in pre-enrollment evaluation, there will be a large increase in the number of people taking placement tests and using the learning centers.
* Some CLC students have to wait in line for certain instructional materials.
* Respiratory Therapy students need patient-care simulations which supplant hazardous initial clinical experiences.
* Faculty in many areas report considerable time spent in hand-scoring tests, hand recording progress data, and hand calculating grades.
* Immediate feedback on tests is being deterred by slow hand grading.

Tools for Educational Analysis. Instructors believe that coordination and better evaluation of programs would enhance students' learning.

* Many faculty feel a need for automated test grading and items analysis to more easily define student achievement profiles.
* A computerized readability analysis tool would be helpful to evaluate instructional materials.
* A statistical routine package such as SAS or SPSS is needed to enhance the faculties' analysis of instructional data.

* Preparing, revising and grading tests is very time consuming.
* Occasionally, student information needed for instructional decisions is not readily available.
* Faculty express a need for the coordination of curriculum needs and overlap across common areas.
* There is a need for more accurate measurement of student instructional time in the learning centers.
* Some learning center faculty recognize that certain diagnostic - prescriptive activities could be automated because the process is algorithmic using paper and pencil.
* Faculty expressed a real need for more time to research and review new or improved instructional materials.
* Many of the records in the learning center are incomplete, misfiled, or are unnecessarily duplicated.
* There is a need for more timely information of student progress.
* In order to follow up on students who drop out of the learning centers, the files must be hand sorted.
  Faculty would like to be able to analyze student learning style/preferences (i.e., cognitive style mapping) to determine the best instructional delivery method.

Staff Development. There is concern among faculty as to their level of understanding, knowledge, and skills in CBE.

* Faculty need training in the development of CBE.
* Faculty need tools for "authoring" CBE.

Computer Literacy. Faculty believe that faculty, staff, and students need to be computer literate.

* Opportunities and incentives for training are needed to encourage faculty to become computer literate.
* Students, as well as faculty and staff, need exposure and insight to terminals and data processing principles (computer literacy).

Instructional Efficiency. Faculty believe that computer hardware needs to be located for maximum usage with some terminals serving both instructional and/or administrative needs.

* The learning centers need terminals right in the centers.
* The Boone secretarial program needs a printer in the immediate vicinity of the terminal used for DP training.
* Ideally, one terminal is needed for every two students receiving computer operator training. A minimum of 5 terminals should be dedicated to the operations program for 3 hours per day (daytime students only). A minimum of 20 terminals are needed for programming instruction.
* In certain instances, the same terminal must be used for both instructional and administrative purposes.
* There should be a better coordination between instructional programs, Learning Centers, and student services.

SECTION IV. ARCHITECTURAL OVERVIEW & MODULE DEFINITION

Objectives of the System

Prior to the design phase of the CBE system, five objectives were identified. These five objectives are:

To Improve Instructional Experiences For Students. Improving instructional experiences for students is of prime importance in the areas of job skills, developmental skills, collegiate skills and job/life skills. This goal can be achieved by providing efficient, consistent and transportable units of education. In addition, new courses should be offered and services both on and off campus should be enhanced.

To Use the Computer as an Alternate Mode of Delivery For Instruction and Testing. Alternate modes of instructional delivery have continually been investigated throughout the college and computer based education, including the use of the computer in testing, should be included with those delivery methods.

To Provide Tools For Educational Analysis. Several tools for educational analysis should be available to provide information which instructors can use to improve the instructional process. Cognitive mapping has been identified as one of these tools to aid instructors. In addition, item analysis and other test analyses should be considered for possible computerization.

To Provide Staff Development in the Area of CBE. Staff development in the area of computer based education is important to the success of the system. Instructors need to understand the use of CBE and may want to become actively involved in the actual development process.

To Achieve Computer Literacy Among Staff and Students. Computer literacy for both staff and students was identified as an important goal of the system. Since computer technology is spanning most career areas, the basis for a computer literacy core requirement should be included in the system.

Architectural Overview

The CBE system was designed based on the information gathered by interviews. The various areas of interest were categorized and drawn in a hierarchical chart. The initial levels of the architecture are shown in Figure IV-1. The remaining levels appear in Appendix E.

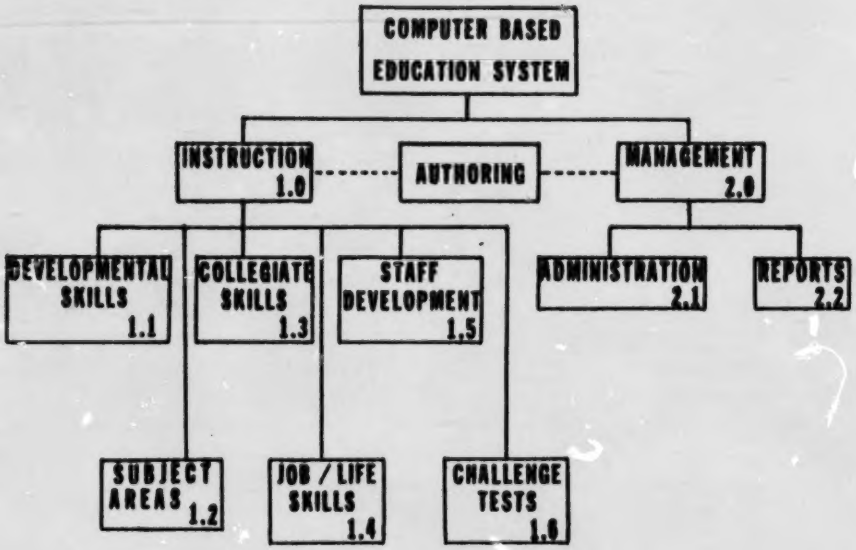


Figure IV-1. CBE System Architecture

This architecture represents categorization by content rather than by traditional divisional lines thus meeting the objective of transportability of modules. Most elements of the system were broken down to the module level while some elements remain for further study. Modules appear in the hierarchy in lower case letters and represent units for possible implementation. Terminal elements of the system appearing in capital letters need further definition before becoming candidates for implementation. Approximately 120 different modules were identified in the initial system design.

Module Definition

120 modules are included in the Computer Based Education System. The modules from the initial system design were narrowed down to a workable number of modules for implementation. This process of module definition involved prioritization of modules, identification of modules unique to DMACC and the search for modules already available from outside sources.

Weighting factors for the modules were chosen according to the objectives of the systems. The weights chosen ranged from a value of 100 for those modules considered to be mandatory to a value of one (1) for those modules considered to be highly visible. Each module was evaluated to determine those objectives which would be met and the corresponding weights were recorded. Total weights were accumulated for each module and 28 modules were prioritized for inclusion in the three

year implementation plan. The weighting and prioritization schedule is contained in Appendix E.

Some of the modules identified for implementation are unique to DMACC and thus require local development. Among these modules are those which orient students and staff to the library and DMACC.

A search was made for modules available from outside sources in order to avoid unnecessary duplication of module development. The study team visited two schools actively involved in CBE: Fox Valley Technical Institute in Appleton, Wisconsin and San Antonio College in San Antonio, Texas. Correspondence, agenda, and related material for these reference visits are contained in Appendix G. Other institutions were investigated via a literature search, phone calls and letters of inquiry. The kinds of information necessary to make adoption decisions, summaries of the telephone search, and the form letter for mail inquiry are contained in Appendix H. Several modules that appear to meet our needs were located, however, they have not yet been previewed.

CLC Data Base

The Comprehensive Learning Center (CLC) presented a particular problem in terms of storage and retrieval of student records. To deal with this problem, a preliminary data base was designed and is illustrated in Appendix J.

Implementation Matrix

The architectural design phase identified 28 high priority modules. A matrix/calendar of implementation (Figure V-1) was constructed which, in addition to these modules, includes personnel and hardware/software requirements. The eight basic areas of implementation are listed in the left-most column of Figure V-1.

Realizing that both CBE staff and faculty will need time to preview some materials and write other materials, module implementation was spread over nine quarters (Summer, 1980, through Summer, 1982). The first CBE modules are scheduled to be implemented in the Fall, 1980, quarter. They include:

* Comprehensive Learning Center--basic math;
* Data Processing Education--Introducing the Computer, Numbering Systems, CICS, and the 3270 terminal orientation module;
* and, Accounting--the General Ledger Simulation.

Many of these modules are already in use by other educational institutions. Some modules which are to be developed are already organized in a different form, but are easily adaptable to CBE. For instance, the Accounting Inventory Simulation which is scheduled to be developed in CBE form during the Summer of 1981 and implemented in subsequent Fall quarter, is presently being used in some accounting classes in a non-CBE form.

Many of the remaining modules (Table V-1), such as Auto Parts Inventory Control, have high faculty interest but must be organized and either located or locally developed. Other modules, such as DMACC orientation, are clearly of local interest and origin.

T-Accounts
Accounts Payable (Simulation)
Bank Reconciliation (Simulation)
Job & Process Acct. (Simulation)
Depreciation
Accounting Terms (Tutorial)
Financial Statements (CAI Tutorial)
Present Value Concepts (Tutorial)
Inventories (Tutorial)
Current Value Concepts (Tutorial)
Statistics
Console Operator
Peripheral Operator
VM
BAL
RPG II
BASIC
PASCAL
Voting Pattern Simulation
Stock Market Game
Math for Nursing
Note Taking
Test Taking
Resumes
Job Application Forms
Interview Techniques
A & P
Human Resources Management
Geometry
Reading Level
Power
Tax Form Simulation
DMACC Orientation
Listening Skills
Data Entry Auto Parts
Criminal Justice Simulation
Decision/Utility/Pref. Theory
Writing
Syllogistic Logic
Legal Resume & Writing
Operational Systems Simulation
Library Orientation
Library Usage
Job Advancement
Chemical Titrations
ESL
Tests (Med Tech, Med Term, Body Struc.)
Front Office Data Entry
Text Process
Administrative Process
Non-Credit Adult Education
Research Paper
Certificate Program Test
Police Radio Dispatch
Business Communications
American Government
American History
Recipe Calculation
Iowa Government
Short Stories

TABLE V-1 HIGH PRIORITY MODULES NOT IN IMPLEMENTATION PLAN

Hardware Needs

The number of terminals (Table V-2) required was calculated by dividing the number of user hours per quarter by the number of available hours per quarter per terminal.

Based on a 55-day quarter, a 10-hour day, and 60% usage, we estimate 330 hours available per quarter per terminal.

User hours per quarter (Figure V-2) were calculated by multiplying the annual number of users of a module (Table VI-2) by the number of hours per module and then dividing by 4.

Example: Fall '80

Basic Math 800 users x 20 hrs/user = 16,000 hrs.

General Ledger 450 users x 7 hrs/user = 3,150 hrs.
Simulation

Total Non DP hrs. = 19,150 hrs. annually

Average per quarter = 4,790 hrs.

Similarly DP modules average 610 hrs/quarter

These quarter totals are accumulated in Table V-2.

	FALL 80	WINTER 80-81	SPRING 81	SUMMER 81	FALL 81	WINTER 81-82	SPRING 82	SUMMER 82
Non DP terminal hours	4790	5940	6990	6990	7300	8120	8120	10120
DP terminal hours	610	760	840	1050	1050	1050	1050	1050
Non DP CBE terminals	16*	19	23	23	25**	27	27	33
DP CBE terminals	2	3	3	4	4	4	4	4
TOTAL CBE TERMINALS	18	22	26	27	29	31	31	37
DP Educ. terminals	12	27	27	26	26	26	26	26
TOTAL TERMINALS	30	49	53	53	55	57	57	63

* One extra terminal assigned to the Administrator's Office.
** One Extra terminal assigned to the CLC.
# of CBE terminals was based on 330 hours/quarter/terminal.

TABLE V-2 TERMINAL REQUIREMENTS

There are at present 2 clusters of terminals: one cluster containing 9 terminals in Building 6 on the Ankeny campus; the other cluster containing 5 in Building 8 on the Ankeny campus. We recommend maintaining the cluster concept. Building 8 will eventually require two clusters: one primarily data processing education and the other CBE. These locations will be available to a variety of users.

FIGURE V-1a. IMPLEMENTATION MATRIX

	SUMMER '80	FALL '80
PERSONNEL	Assign ½ time Director. CBE. Under go CBE Admin. CWIII & CSF trng. System Orientation	Assign 2nd ½ time CBE person. Under go CBE admin. CW III & CSF trng.
CBE Staff Activities	Preview: algebra- intro to comp. - numb. sys. - basic math - econ simula- tion. Disseminate information on CBE to Faculty & Staff	Preview: PLI - CMS - DMS - grammar - spelling - probability
Hardware/ Software	(6/1) 4331-RJE-To 158 (6/15) 4331/158 BSC Line (7/1) MSG on 4331 capacity reader on 158	capacity reading on 4331 ARES
Learning Center		Basic Math
Data Processing		Numbering Systems Intro. the comp. CICS 3270
Accounting		General Ledger simulation
Math		
Other	Authoring (2) Administrator	

FIGURE V-1b.

	WINTER '80-'81	SPRING '81
PERSONNEL		Director Attend ADCIS
CBE Staff Activities	Plan summer CBE dev. program. Prepare prelim. FY '82 budget	Preview: COBOL - Metrics - Trig. - Calculus - medical simul. Prepare FY '83 objectives
Hardware/Software	SNA network in place	4341 installed DMACC with CICS, DLI
Learning Center	EPIC/FAST Define Data Base	Grammar Spelling Write data base access programs
Data Processing	PLI Fortran	CMS DMS
Accounting	Linear Programming Accounts/Receivable simulation	
Math	Algebra	Probability
Other	Econ. Simulations SPSS	

Figure V-1c.

	Summer '81	Fall '81
Personnel	Assign full-time CBE programmer. Undergo CWIII & CSF training.	
CBE Staff Activities	Prepare & File annual report. Conduct summer CBE development prog.	
Hardware/Software	Academic batch on 4341 IIS on 4341	
Learning Center	Write test Macro →	→ Metrics
Data Processing	COBOL	
Accounting	Write Inventories simulation →	→
Math		Trigonometry Calculus
Other	Write Medical/ Legal Term. →	→ Medical Simulation

Figure V-1d.

PERSONNEL	Winter '81-'82	Spring '82 1 staff attend ADCIS	Summer '82
CBE Staff Activities	Plann summer CBE dev. prog. Prepare prelim. FY '83 budget	Prepare FY '84 objectives	Prepare & File annual report
Hardware/Software			
Learning Center	Write Reading Comprehension Data Entry of tests	→	Reading comprehension →
Data Processing			
Accounting	Inventories Sim. Write Accounting cycle tutorial	→	→
Math			
Other	Med. Term. Legal Term.		

Figure V-2 a TERMINAL USE CALCULATION

	Summer '80	Fall '80	Winter '80-'81	Spring '81
Personnel				
CBE Staff Activities				
Hardware/ Software				
Learning Center		Basic Math 300x20		Grammar 400x8 Spelling 400x2
Data Processing		#Sys. 220x2 Intro 180x2 comp CICS 75x9 3270 320x3	PLI 40x9 FORTRAN 40x6	CMS 20x9 DMS 20x6
Accounting		Gen Ledger Sim 450 x 7	Lin. Pgm. 110x1 NR Sim 100x5	
Math			Algebra 250x10	Probability 110 x 2
Other			Econ. Sim. 300 x 5	
		D.P. 610 Others 4790	D. P. 150 Others 1150	D.P. 80 Others 1 50

Figure v-2b TERMINAL USE CALCULATION

Summer '81	Fall '81	Winter '81-'82	Spring '82	Summer '82
	Metrics 130x2			Reading Comprehension 400 x 20
COBOL 165x5				
		Inventories Sim 300 x 3		
	Trig 105x3 Calculus 30x20			
	Medical Sim. 25 x 2	Med. Term . 200 x 8 Legal Term. 200 x 4		
D.P. 210 Others 0	D.P. 0 Others 310	D.P. 0 Others 820	D.P. 0 Others 0	D. P. 0 Others 2000

System Configuration

Figure V-3 shows the system anticipated upon first CBE implementation. The IBM 4331 at DMACC and the IBM 370/158 at Kirkwood will communicate, but all modules operating under the management of the Interactive Instructional System (IIS) will run on the 158. It is expected that administrative functions will exhaust most of the 4331's capacity.

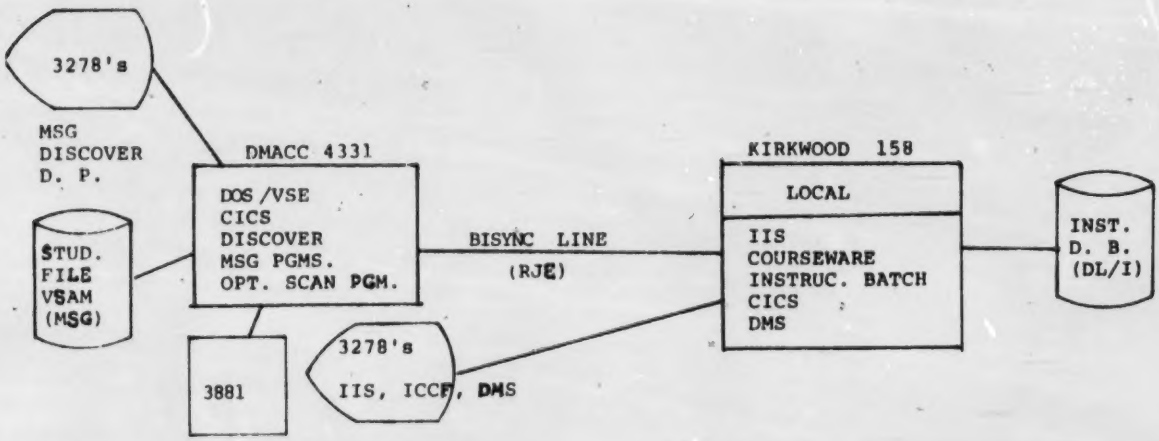


Figure V-3. Computer System Configuration Anticipated As Of July 1, 1980

Figure V-4 shows the statewide system anticipated in the Spring of '81. This system would allow any user at any location to run a program without regard for what hardware (4341, 4331s at ours and other institutions, or 370/158) is performing the task; that is, the user will sit at a terminal and access an instructional application which, although it may actually be executing on a computer at another institution, will appear as if it is executing on his local computer.

Personnel Requirements

Our study led us to consider 1 CBE system administrator and 1 coder/programmer. The system administrator's tasks could be divided among 2-4 persons, but we recommend 1 person. This person should have had some management experience, good communication ability, and skills in media selection, CBE, programming, and data processing concepts. A complete description of the responsibilities, relationships, and qualifications of the system administrator are listed in Appendix I.

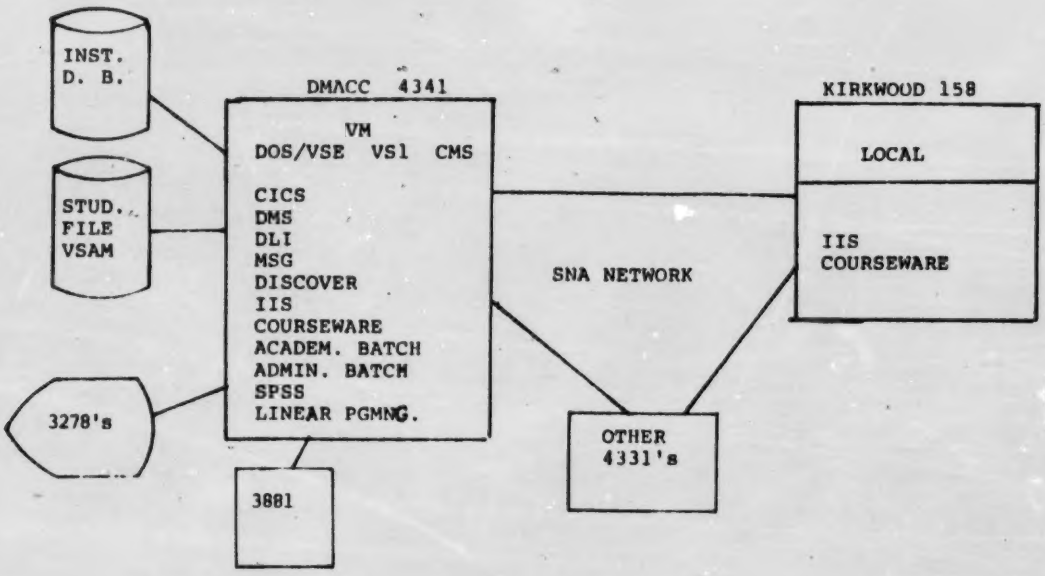


Figure V-3. Computer System Configuration Anticipated As Of July 1, 1981

SECTION VI. COST and BENEFIT ANALYSIS

Costs

The costs of implementing and operating the Computer Based Education (CBE) System are summarized in Table VI-1. We estimate that in the first year of the implementation plan, costs will amount to $80,041. The cost should peak at $153,490 in the second year. The cost for Fiscal Year 1983, the third year of operation, should approach average annual operating costs for future years and could serve as a base year for future budgeting (barring unforeseen changes in instruction, technology, inflation, and philosophy).

	FY81	FY82	FY83
Courseware	24,769	30,224	1,958
Instructional	12,575	21,370	710
Non-instructional	12,194	8,854	1,248
Administrative	41,850	65,858	74,723
Hardware/Software	13,422	57,408	61,043
Total	80,041	153,490	137,724

TABLE VI-1. SUMMARY COSTS

The costs are broken into three categories: courseware, administration, and hardware/software. Courseware costs are the cost of leasing-purchasing currently available computerized instructional materials or the cost of developing new materials. Note that there is a sub-division of courseware costs labeled "non-instructional." These are computerized instructional services, such as test scoring, for faculty rather than instructional materials for students. Administrative costs include the salaries of the staff which manage and service the CBE system, as well as funds for relevant faculty development, system support, and improvement. Hardware/Software costs reflect our fair share of the cost of operating and maintaining the computer system which houses our CBE System.

Courseware

Instructional Courseware Costs. Table VI-2 provides a detailed view of the instructional courseware costs. It shows the quarter-by-

quarter impact of the implementation. For instance, the modules to be implemented in the Fall quarter, 1980, will cost $5,600 the first year, $3,720 the second year, and $520 (paid off) in the third year. However, these six modules offer a total of 43 hours of instruction and are expected to be used by 2,075 students each year. The effects in Table VI-2 are cumulative so that by the end of the implementation plan we expect to be offering 173 hours of instruction and serving 5,320 students, all for a courseware cost of $34,655 (or slightly less than 4 cents per instructional hour per student).

Module	cont hr.	Users					Cost			Cost ($)/ user-hr.
		AS	AE	CE	oth	Total	FY81	FY82	FY83	
Fall 1980							5,600	3,720	520	
Basic Math	20	30	800			830	2,600	3,120	520	0.376
Numbering Systems	2	120		100		220	1,000	200		2.727
Intro. the Computer	2	80		100		180	2,000	400		6.667
CICS	9		25	50		75				
"3270"	3	180		120	20	320				
General Ledger Sim.	7	300	50	100		450				
Winter 1980-81							2,105	1,450	0	
PLI	9			40		40	2,030	1,450		9.667
FORTRAN	6			40		40	75			0.313
Linear Programming	1	50		60		110				
Accts. Receiv. Sim.	5			100		100				
Algebra	10	150				150	100			0.067
Economics Sim.	5	2200		100		300	1,000			0.667
Spring 1981							3,770	6,840	0	
Grammar (Comm. S.)	8		400			400	1,500	3,000		1.406
Spelling	2		400			400	50			0.063
CMS	9			20		20	1,000	2,000		16.667
DMS	6			20		20	920	1,840		23.0
Probability	2	50		60		110	300			1.364
Summer 1981							0	75	0	
COBOL	5		75	90		165		75		0.091
Fall 1981							0	1,235	190	
Matrics	2		30	100		130		950	190	4.385
Trig	3	75	30			105		75		0.238
Calculus	20	30				30		60		0.10
Medical Sim.	2			25		25		150		3.00
Winter 1981-82							0	5,250	0	
Inventories Sim.	3	200		100		300		1,050*		1.167
Medical Term.	8			200		200		2,800*		1.75
Legal Term.	4			200		200		1,400*		1.75
Spring 1982							0	0	0	
Summer 1982							0	2,800	0	
Reading	20		400			400		2,800*		
Total lease-purchase							12,575	13,320	710	
Total local development								8,050		
Total courseware							12,575	21,370	710	
Total contact hours of instruction — 173										
Total number of students served						5320**				

*to be developed locally

**may include some duplication since, for instance, the same student may take both the Basic Math and Reading modules.

TABLE VI-2. INSTRUCTIONAL COURSEWARE COSTS

We expect that the major portion of the courseware used on the DMACC CBE System will be "imported"; that is, the materials which were developed elsewhere and deemed useful in our setting--much like textbooks. Currently, there is great disparity in both the cost and quality of currently available computerized instructional materials. Several national-scope agencies are working to correct this problem. As their work and effort have impact on computer based education, we expect to be able to acquire high quality computer based instruction at a moderating cost.

Non-Instructional Costs. Table VI-3 provides a detailed summary of the non-instructional module costs. EPIC/FAST is an IBM Program Product which processes the data from the optical reader. This is the program which translates the marks on test response sheets into useable data. ARES (A Response Evaluation System) is a program product developed at Fox Valley Technical Institute and marketed by IBM. It provides an important series of reports which supplement the reports generated by the Interactive Instructional System (IIS). The reports generated by IIS and ARES constitute an instructional management information system. The test development macros are a set of routines which, given a test item bank stored in the computer, can generate a test to meet a number of instructor-specified parameters (e.g., randomly-generated items). The Comprehensive Learning Center database and programs constitute the automated student record system. Its development would be contingent upon development service from the DMACC Data Systems department.

Module	COST FY81	FY82	FY83	Comments
EPIC/FAST	728	1,248	1,248	continues-license
CLC database definition	4,400*			local dev. - DS
CLC database programs	5,866*	5,866*		local dev. - DS
Test development macros		1,500		
ARES	1,200	240		
Total lease-purchase	1,928	2,988	1,248	
Total local development	10,266	5,866		
Total	12,194	8,854	1,248	

TABLE VI-3. NON-INSTRUCTIONAL COURSEWARE COSTS

Costs of Administration

The administrative cost details are summarized in Table VI-4. The items of note are the personnel: a director, programmer/coder, undesignated courseware, incentives, travel, and equipment. The equipment costs are for office and work space furnishings. The travel cost will be incurred by attending power source (KCC) user meetings and special interest group (SIG) meetings for CBE. Because of the state of the art

in CBE communication, SIG meetings are the best forum (in many cases, the only) for locating quality computerized instructional materials and improvements in CBE technology.

	FY81	FY82	FY83
Salaries	30,125	55,260	60,786
Director (2 mos. ¼-time-FY81)	26,015	31,220	34,342
programmer/coder		16,500	18,150
fringe benefits (15.8%)	4,110	7,540	8,294
Contracted Services	6,200	6,820	10,382
undesignated courseware	500	550	3,485
word processing center	1,200	1,320	1,452
incentives/in-service	4,500	4,950	5,445
Materials & Supplies	500	550	605
Travel	2,025	2,228	2,450
in-state	525	578	635
out-state	1,500	1,650	1,815
Promotion	500	500	500
Equipment	2,500	500	
Total	41,850	65,858	74,723

TABLE VI-4. ADMINISTRATIVE COSTS

It is anticipated that an incentive/in-service program will be needed to expand the faculty user base of DMACC CBE. The formula adopted for cost estimation was found at Fox Valley Technical Institute. It consisted of a five member faculty "class" supported by stipend for 120 hour each at a convenient time (summer). The first 30 hours is spent in a CBE authoring workshop. The remainder of the time is spent developing approximately two hours (terminal time) of computer based instruction/testing.

After the acquisition of the modules in Table VI-2, funds will be necessary to "import" other computerized instructional materials as justified. This cost is included as "undesignated courseware."

The notable points in the projected personnel costs are two: amount and timing. The programmer/coder is not scheduled for addition until developmental needs surface in Summer, 1981. The cost of this person is based on the projected starting salary of a DMACC programming graduate. The cost of the director is based on reassignment of a person on level eight of the administrative salary schedule.

Hardware/Software Cost Considerations

The hardware/software costs summarized in Table VI-5 are partially explained by the Table notes. However, one additional point must be made. The costs projected reflect the opinion that after the first year of operation, the DMACC CBE load will, when taken with the other computer service requirements, justify an on-campus computer equivalent to an IBM 4341.

	FY81	FY82	FY83	Comments
Hardware	11,112	52,788	56,423	
machine/CPU/storage		34,248	36,048	note 1
controllers @ 471.60/mo.	7,074	11,319	11,319	note 2
terminals (3278) @ 61.20/mo.	4,038	7,221	9,056	note 3
Software (IIS)	2,310	4,620	4,620	note 4
Total	13,422	57,408	61,043	

NOTES:

1. FY81: Costs are charged from consortium IBM 370/158 on a usage basis and cannot be reliably predicted.
   FY82: Based on our CBE housed in a local IBM 4341 (2 meg) @ 2,854.00 per month. This represents 20% of the total cost of the machine and available storage (administrative--50%; Career Education Data Processing programs--30%; CBE--20%).
   FY83: The IBM 4341 should have been upgraded to 4 meg. @ 3,004.00 per month. This represents our 20% share.

2. FY81: IBM 3274 controllers are required for the terminal clusters. One unit will suffice until the Spring quarter, when a second controller will be required to handle the added terminals.
   FY82 & FY83: Represents a total of 2 IBM 3274 controllers.

3. See Table V-2 for the Terminal requirements. These costs are for only those terminals serving the institutional CBE requirements (terminals dedicated to non-CBE Career Education Data Processing programs are not included).

4. FY81: IIS resident in consortium IBM 370/158. This represents our share--50% of the consortium usage.
   FY82 & FY83: IIS resident in local IBM 4341. This represents 100% of the total cost.

TABLE VI-5. HARDWARE/SOFTWARE COSTS

The above, then, constitute those cost issues which we foresee in implementing and operating the CBE system we recommend. While these costs are substantial, we feel that there is a host of benefits to be derived from the system and that there will be a substantial future net return on the investment for DMACC and its students.

Benefits

The benefits which we anticipate will be derived from the system are of several types. The most significant is the improved quality of instruction which will be accounted for in the number of graduates who, because of CBE, are able to enter and contribute an additional measure to their personal career and society. The other types of benefits also contribute to the improved quality of instruction. They include: Time saved from repetitive/clerical tasks which can be reapplied to professional teaching tasks; improved record keeping which allows more timely professional attention to learning problems; and, students retained because of timely remedial or compensatory instruction. These four classes of benefits:

IMPROVED QUALITY OF INSTRUCTION
TIME SAVINGS
IMPROVED RECORD KEEPING, AND
RETAINED STUDENTS

manifest themselves in a host of very specific benefits. More than a dozen are defined below.

Alternate Delivery Systems. Computer based education offers an alternative delivery system which will accomodate a different learning mode preference by students. This should aid in retaining some of our current students who are dissatisfied with the delivery systems currently available to them. In the same manner it should attract new students for the same reasons.

Flexible Learning Resource. Currently, many students find that they must extend their graduation date because they failed or missed courses in the proper sequence. These courses could not be taken again until a full section could be scheduled. Computer based education offers a flexible learning resource which can accommodate the problem by allowing required instruction taken in a timely manner. Thus, the student can graduate "on time."

Continual Availability of the Instructional Resource. On-call availability of the instructional resource (computer based education) would improve student satisfaction and reduce frustration which results from the inability to confer with an instructor in a timely fashion.

Better Use of Professionals' Time. Faculty time saved by automating test grading, record keeping, test generation, report generation, and the provision of readily accessible information, will allow more time for teachers to interact with students and engage in instructional improvement.

Many of our faculty noted that they spend an inordinate amount of time in test grading and test generation. A compilation of information that was gathered during the needs assessment section of the project indicated that when all of the professional staff in the Ankeny Campus CLC were added together, nearly two full persons worth of time per year could be redirected saved if there was a test grading function available in the CBE system. Enough other faculty expressed the same sort of concern that we can project the function for test grading which was built into the CBE system would allow at least 5% of the instructional's staff to be redirected to more professional activities.

Produce Accurate CLC Records. The Comprehensive Learning Center handles a large number of students. Some students work on comprehensive Adult Basic Education programs while others take only a short course of instruction. Each of these students has an individual data base and progress record. A centralized data base of the student records would insure that duplication does not occur. In addition, the data base and its input/output programs would insure that the records were accurate, complete, and available on a timely basis.

Enhanced Staff and Student Computer Literacy. As our society progresses, computer literacy is emerging as a requirement of the functioning adult. Computer literacy affects both our students and our staff. Our graduating students must be able to interact with the data processing function of any employer. Our faculty and staff are beginning to recognize the value of computer technology as an educational resource. The recognition of the role and value of computer technology is extremely important for these two groups as they function in their jobs.

Increased Statistical Research Capability. The Computer Based Education System will collect a great deal of data which may be used for cross sectional and longitudinal studies. This would provide an excellent data base for institutional research and development in the instructional areas.

New Perspectives in Teaching. The Computer Based Education System provides a new element in the instructional environment. As our faculty comes to grips with this new resource teaching tool, there will be two positive consequences. The addition of a new perspective for teaching leads to increased enthusiasm on the part of the professional teacher who is always looking for an alternative which will suit the needs of individual learners. At the same time the addition of any new alternative learning resource to the repertoire of any teacher must certainly result in the professional growth of that person.

Occupational Simulation. Instructional simulation is a controlled model of reality. It allows the instructor to control all of the variables that enter into a complex problem solving situation. Such control is generally straight forward and logical, but extremely complex. This is a particular function that the computer performs extremely well. The study team recognizes the capacity of Computer Based Education in this area. Thus, several simulation activities have been included in the implementation plan and we anticipate that Computer Based Education will foster the increased use of simulation experiences for our students. Among the benefits that will be reaped from simulation experiences are more realistic preparation for job skills and safer preparation for certain clinical or laboratory experiences. For instance, currently respiratory therapy students in the clinical setting cannot always carry through on a course of action with a patient to see the consequences when the course of action is hazardous to the respiratory patient. The variety of courses of action and subsequent consequences are so broad that only a computer simulation can effectively provide an adequate preclinical experience for the students.

Increased Institutional Communication. We are recommending that the Computer Based Education System for DMACC be administered as a service to all areas within the college. Because of the all-college service nature of the system, the modules in the system will have an impact across departmental/divisional/other lines. Such a posture avoids duplication of curriculum materials and standardizes the curricula across divisional lines where it is appropriate.

Increased Productivity. The previously mentioned time savings for the professionals in the Comprehensive Learning Center will yield increased productivity in the facility. This means that those students who use the CLC for remedial instruction or to prepare themselves for more difficult courses in their college program, will be better prepared for the later instruction. This will benefit all the students in the subsequent college courses by lowering the frustration which results from being ill prepared and unable to make better use of their time. The instructors will also be benefited by being able to reach to more homogeneous groups. Teaching to a group of learners who are more alike in their learning abilities and development will reduce the time spent bringing the poorer students up to class standards. The net result of this will be greatly improved learning environment.

Reduced Student Attrition. It is estimated that attrition due to low basic skills can be significantly reduced since an environment is provided which does not require that a student's deficiencies be exposed to other students. For example, a student need not physically attend the learning center after initial enrollment in a basic math program. He/she could be remediated through a computer based module taken on a terminal in one of the multi-disciplinary clusters amid students from all areas of the college taking all manner of instruction.

Increased Student Retention. In addition, there is at least one benefit area which can, to some degree, be quantified--the area of student retention.

Unfortunately, in our programs which do not have "quarterly intake," when a student withdraws from the program that income is lost while the expenditures for operating the program remain essentially the same as when all student slots are full. The expenditures are made in anticipation of a full section. While experience with attrition has taught us that certain conservation can occur with materials and supplies costs, the bulk of instructional costs--salaries and facilities--are based on "full" sections. In other words, instructors and classroom/laboratories must be provided whether the section operates at a full complement of 20 students or with 15 students after 25% attrition.

Each year the College loses a great deal of income because students leave their programs before completion. The reasons for this attrition are many and varied. Some students become attrition statistics because they simply lose interest in their program, some because they find rewarding full-time employment (often because of competencies acquired at DMACC). Some students leave for personal/family reasons. Often, the reasons a student gives for withdrawing from his/her program of study are only a mask for the real reasons.

One reason some students become attrition statistics is that they don't possess the necessary basic skills to compete in the stringent,

demanding academic or vocational program of their choice. The faculty we interviewed gave us startling benchmarks: "75% of the students with reading ability below 9th grade fail. The shop manuals are written at 13th grade level!" Or, "We lost 9 students last year because of poor math skills."

Table VI-6 lists 6 Career Education programs which were able to relate some specific attrition values to basic skill competency. Admittedly, the number of students we expect to "reclaim," through the use of a CBE module, is speculation. However, we believe these estimates are conservative and sufficiently founded. The 6 programs listed are those which gave us specific information. They are members of a select subset of our college student population--full-time, day, Career Education, which numbers about 2300 in total.

Program	Enrollment	% Attrition	Reason for expected reclamation module	# Expected Reclaimed	Qtr. Remaining After Reclaimed	Rate-Income/ Quarter	Potential Income FY82	Potential Income FY83	
Automotive	80	40	Basic Math	8	6	907.5	43,560	43,560	
			Reading	8	6	907.5		43,560	note 2
Respiratory Therapy	40	30	Basic Math Reading Algebra	2	4	907.5	7,260	7,260	
Nursing	280	20	Basic Math	5	6	907.5	27,225	27,225	
			Reading	3	6	907.5		16,335	
Food Service	30	50	Basic Math	3	5	907.5	13,613	13,613	
Accounting	200	50	Basic Math	6	4	907.5	21,780	21,780	
Electronics	70	30	Basic Math	5	2	907.5	9,075	9,075	
			Algebra	2	4	907.5	7,260	7,260	
Total	700			42	43		129,773	189,668	

NOTES:

1. Reflects a one year delay to accommodate the state funding formula.
2. The READING Module is planned for implementation in the second year of operation.

TABLE VI-6. INCOME FROM REDUCED ATTRITION

Of the 700 students enrolled in the programs listed in Table VI-6, we anticipate that approximately one-third, or 236, will become attrition statistics. Of these 236, we expect to reclaim 42 by compensatory or remedial instruction through the CBE System. By extending these ratios to the remaining 1600 full-time, day Career Education students, we can

project that we can reclaim an additional 96 students. This could yield a potential income savings of nearly $426,000 in FY 1982 and $623,000 in FY83 for Career Education. Of course these figures should be discounted to a degree where open-entry, or quarterly intake of students, allows the refilling of a student-slot in a program.

The "income-per-quarter rate" values in Table VI-6 deserve special explanation. The rate is computed using the following variables:

I = income per quarter
Ch = number of contact hours per quarter per student
IC = income per contact hour

The value for IC can be found in Appendix D Table D-1. The IC values were derived from 1979 institutional statistics for contact hours and income. The Ch value is computed by multiplying the number of days in a quarter by the number of contact hours per day. The value used in our current calculations is 330 (55 days x 6 hours). The formula for computing the rate is:

$$I = Ch \times IC$$

In the case of Career Education, the value of I is:

$$I = 330 \times 2.75$$
$$I = 907.50 \text{ income per quarter per student}$$

Extension of the proportion of "reclaimed" students to Arts & Sciences and Adult & Continuing Education is risky. In our estimates for Career Education, we used 6%. Because the nature of sectioning and programming is significantly different in Arts & Sciences and Adult & Continuing it would be prudently conservative to suggest that we could "reclaim" 2% of the roughly 1100 full-time students in those division (20 students) per year. If we reclaim those 20 students for 4 quarters each, we realize an additional income of approximately $42,000 (each A&S student generates approximately $525.00 income per quarter).

	FY'81	FY'82	FY'83
Costs	78,811	151,030	135,264
Courseware	24,769	30,224	1,958
Administrative	41,850	65,858	74,723
Hardware/Software	12,192	54,948	58,583
Potential Income		468,373	665,171
Career Education (Table VI-6)		129,773	189,668
Career Education (other)		296,624	433,527
Arts & Sciences and Adult & Cont. Ed		41,976	41,976
Balance	(78,811)	317,343	529,907
Net Return on Investment		$238,532	$768,439
		101 grad.	259 grad.
	intangibles	intangibles	intangibles

TABLE VI-7. RETURN ON INVESTMENT

Based on our projections (Table VI-7 and Figure VI-1), then, in FY82 the institution could realize an income from students who were reclaimed on the order of ½ million dollars. In FY83, we expect that this figure would climb by nearly $200,000 to a total of $700,000 as the effects of adding the reading course to the CBE system in FY82 are felt.

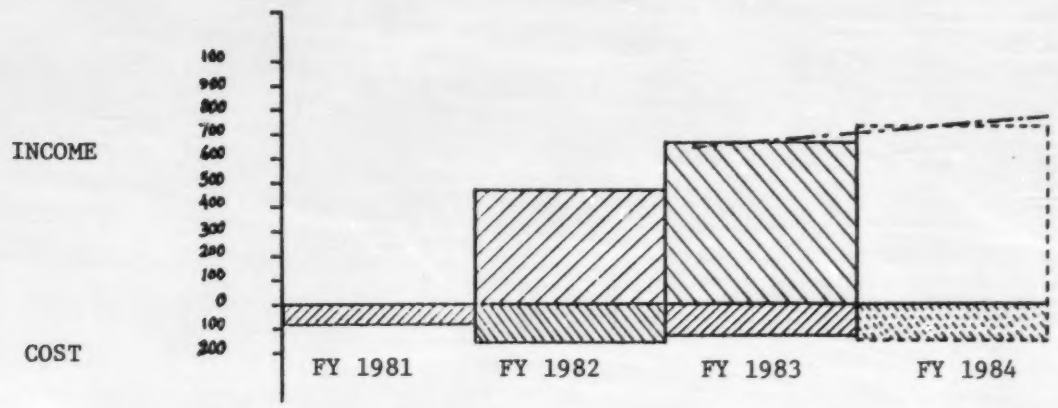


Figure VI-1. Return on Investment

More importantly, we will have fulfilled our mission of successfully graduating 158 individuals who would otherwise have fallen short of their goals.

SECTION VII. RECOMMENDATIONS

The study team's recommendations fall into two categories. The policy recommendations deal with those issues we see which require internal policy decisions so that the recommended Computer Based Education System will have the best possible environment for success. The action recommendations are those steps we think the college should take to insure that computer based education, as an institution wide instructional strategy, becomes a reality and evolves as a viable instruction delivery alternative for the 1980's.

Policy Recommendations

The following policy recommendations should receive action.

1. CBE support should be funded as a service cost without a chargeback to the academic departments, for the following reasons:
   a) Departments and divisions will be encouraged to work together to meet institutional goals.
   b) The resources are available to the total institution.
   c) Participation by faculty will be greater than if charges are made to departments.
   d) Successful programs have used it.

2. Terminal use, disk space and CPU time should be considered a data processing cost and not charged back to departments, for reasons similar to 1) above.

3. Authoring should be encouraged by incentive programs such as release time or additional compensation. The time required to develop CBE material is over and above the normal time an instructor is expected to devote to course development.

4. The back-up of the CBE system is the responsibility of the institutional data processing department.

5. Instructors should be encouraged to include module evaluation as a part of any authored course but will not be required to do so. Any courses acquired from off-campus should be evaluated.

6. Courses developed in-house should be provided to other institutions on the same basis as material in other media.

7. All documentation should be maintained on the computer, using text processing capabilities. This will make documentation readily accessible and easy to change.

8. A policy on who owns copyrights to modules developed in-house needs to be developed.

9. Faculty must maintain personal contact with their students.

Action Recommendations

The following action recommendations should be adopted.

1. The College should adopt the System for Computer Based Education recommended in this report and move ahead with the implementation plan which we have described.

2. The College should investigate, for future implementation, "distributed" CBE (microcomputers at remote sites which communicate on a part-time basis with the host computer). The investigation should move forward as information and experience in "distributed" CBE becomes available.

3. The College should invest further study in the integration of CBE with the other media and delivery systems. This is a very dynamic area as the technologies advance.

4. A need for diagnosing varied learning styles of students was indicated by several staff members. It is recommended that the service of providing this diagnosis be studied further.

5. A formal evaluation of the CBE system should occur at the conclusion of the implementation period.

6. The implementation plan should be expanded as rapidly as possible to include the College's outlying campuses and centers.

7. A plan should be implemented for interfacing the test-item-bank generation function of the Word Processing Center with the central computer of the CBE system.

8. Instruction in some areas should be more competency based, more open-entry/open-exit, and less lock-stepped.

9. As soon as the residence issue of the data entry curriculum has been resolved, the College should investigate and implement the best "key-to-disk" training system for the finalized curriculum.

10. The College should actively investigate and plan the utilization of small "blocks" of instruction (perhaps 2 or 3 weeks in length) which are college-credit bearing and may be chained together to regain the characteristics of our "traditional" college courses.

11. Methods should be investigated which would facilitate a better flow of information about student learning characteristics and problems between the Student Services, the Learning Centers, and the instructional staff.

12. The Application Transfer Team (ATT) methodology has proven very beneficial during the course of this project. We recommend that it be applied in other such problem resolution projects.

SECTION VIII. SUMMARY

The impetus for this project to design a Computer Based Education System grew out of renewed attention to the educational data processing (EDP) needs of DMACC and fellow institutions. WIREC, the Western Iowa Regional EDP Consortium, with its large IBM computer installation at Kirkwood Community College in Cedar Rapids, offers an excellent opportunity for capitalizing on the instructional capabilities of the computer.

Leaders among the faculty and administration at DMACC were quick to realize the potentiality of the situation. They accepted the planning assistance from IBM which led to the identification of a number of priority issues for in-depth study. One of those priority areas was computer based education. Carroll Bennett, Vice President for Instruction, appointed a study committee (a sub-committee of the Curriculum and Instruction Committee) to follow-up on the planning session. On the recommendation of the study committee and others, Bennett decided on an in-depth project to design the optimum use of computer based education at DMACC. Once again the advisory services of IBM were offered and accepted. An IBM project strategy, the application transfer team (ATT) approach, was employed. Bennett named Ted Clinkenbeard, Bob Jansen, Maurice Mitchell, Terri Phares, Gary Wilcox, and Jack Zeller as the project staff. IBM contributed the services of Sue Leslie, Glenn Reinemund, and Luella Webb.

Planning Session

The project activities began on February 28, 1980 with a planning session. The session was attended by nine members of the project staff and nine other faculty and administration leaders. At that time the scope of the project was declared, the areas of emphasis were expressed, and a number of objectives and design criteria were defined.

Scope of the project. The scope of the project was declared to be TO DESIGN THE OPTIMUM UTILIZATION OF COMPUTER BASED EDUCATION AT DMACC.

Areas of Emphasis. To further describe the emphasis of the investigation, the following curricular and instructional issues were stressed:

* skills (job, developmental, collegiate, and placement skills);
* the alternate delivery of instructional modules and testing;
* tools for educational analysis;
* staff development;
* and, computer literacy for both staff and students.

Objectives and Design Criteria. In addition to specifying the scope of the project and its areas of emphasis, a substantial list of requirements were laid on the eventual system. Among these objectives and design criteria were such requirements as to determine the most appropriate subject areas for initial implementation and to enhance and extend DMACC program and course offerings both on and off campus. In all, twelve objectives and design criteria were specified for the system.

Needs Analysis

The needs analysis consisted of an analysis of the faculty's perceived needs in the light of the mission of the Instructional Division and the current use of computers in DMACC instruction. In essence, the mission of the Instructional Division is to provide an education to a broad base of society to meet a variety of needs. This is accomplished through the programming of three lower-order divisions: Career Education; Arts & Sciences; and, Adult & Continuing Education.

Currently the college has at its disposal a wide variety of computer systems. Several of these systems (an IBM 360/30, PDP-8, several HP-9830As, and several APPLE IIs) are utilized in the instructional processes in the Career Education Data Processing, Electronics Maintenance, and Mathematics-Science curricula. In addition, the WIREC IBM 370/158 is being phased into use in the Career Education Data Processing program.

Faculty Interviews. Against this backdrop of mission and computer systems potential, is set the expressed needs of the faculty for instructional computing services. In all, 51 faculty from the principal campuses and instructional functions were formally interviewed to determine their problems, wants, and needs.

Concerns and Needs. The concerns and needs of the faculty span the areas of emphasis declared at the outset of the project: skills; alternate delivery of instructional modules and testing; tools for educational analysis; staff development; computer literacy; and, instructional efficiency. For instance, needs such as the following were reported during the interviews.

* Students in the Auto Parts Program need training in computerized inventory control.
* Many faculty expressed a need for alternative instructional delivery modes which would provide greater instructional flexibility.
* Many faculty felt a need for automated test grading and item analysis to more easily define student achievement profiles.
* Faculty need training in the development of computer based instruction.
* Students, as well as faculty and staff, need exposure and insight to computer terminals and data processing principles (computer literacy).
* The faculty believe that computer hardware needs to be located for maximum usage.

Architectural Overview & Module Definition

Based upon the expressed concerns and needs of the faculty, the Computer Based Education System was designed. The objectives for the system, following the need analysis, became:

* To improve instructional experiences for students;
* To use the computer as an alternate mode of delivery for instruction and testing;
* To provide tools for educational analysis;
* To provide staff development in the area of computer based instruction; and
* To achieve computer literacy among staff and students.

A system was designed which incorporated those functions, human and data processing, necessary to meet these objectives. The architecture of the system is hierarchical and is defined down to the "module" level (Figure IV-1 is repeated here for the sake of convenience). In all, 120 modules were specified, many of these with enough detail to enable immediate implementation. After the system was designed, those modules which were sufficiently defined were subjected to a weighting and prioritizing procedure. As a result, 28 modules were declared "key" and became the foundation for the implementation plan.

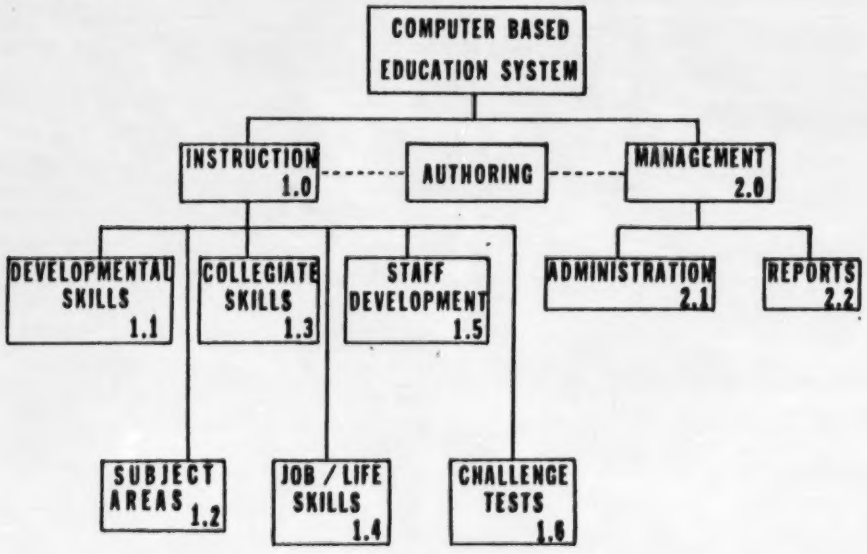


Figure IV-1. CBE System Architecture

Implementation Plan

The plan for implementation of the Computer Based Education System was developed using a "matrix approach." The eight areas of implementation (personnel, CBE staff activities, Hardware/Software, Learning Center, Data Processing, Accounting, Math, and other) comprised one of the dimensions of the matrix. The other dimension was the quarterly academic calendar from Summer, 1980, through Summer, 1982.

The key instructional modules (CBI) satisfied the bulk of the implementation plan ingredients. However, several other CBE system issues were resolved at this point. With the 28 modules and their anticipated annual usage serving as the base (graphically illustrated in Figure VIII-1), hardware and software requirements were defined and projected. These hardware and software requirements were integrated with the hardware and software plans for DMACC and WIREC data systems services. It was determined that with a total of 63 CRT terminals for instructional purposes and (certain additional supporting hardware) by Summer of 1982, the implementation of the 28 modules could be effected.

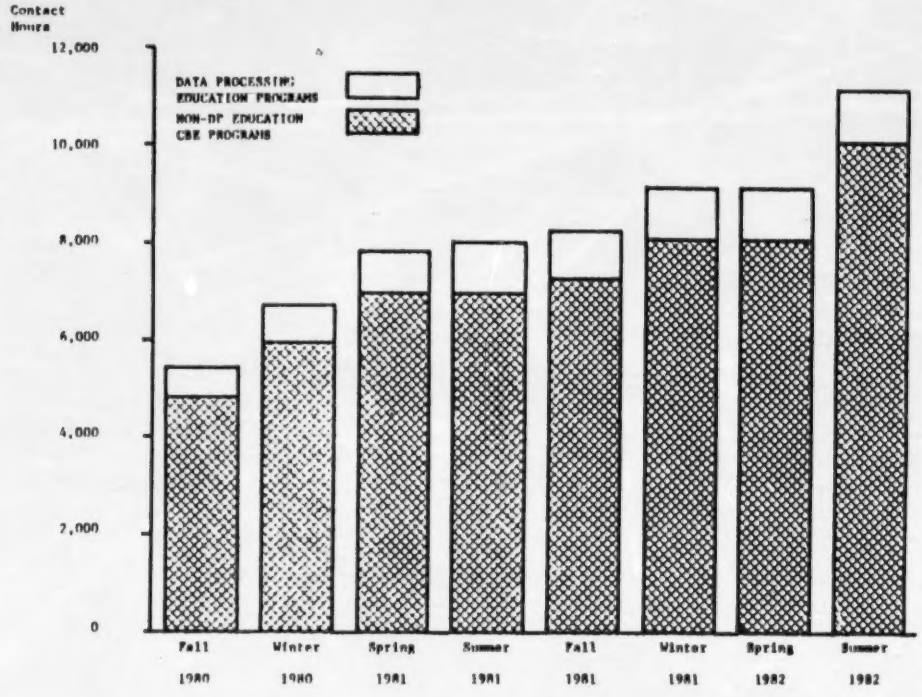


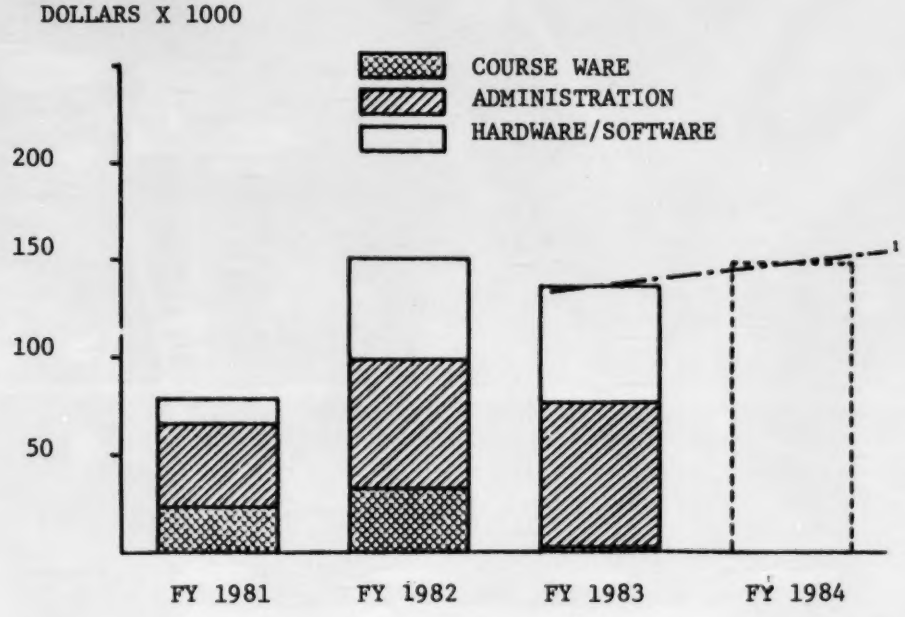
Figure VIII-1. Projected Contact Hours Per Quarter

Finally the personnel and activities required to service the CBE System and the implementation plan were detailed. The staff requirements were defined as a CBE director (full-time by Fall, 1980) and a CBE programmer/coder (full-time by Summer, 1981). The implementation plan specified the nature of (and sometimes the actual) the activities of the system personnel.

Cost and Benefit Analysis

Costs. The costs of implementing and operating the Computer Based Education System are broken into three categories: courseware, administration, and hardware/software. The costs for the first three

years, projected based on the implementation plan, are graphically shown in Figure VIII-2.



Note 1. An inflation rate of 10% was used to forecase the costs in FY 1984.

Figure VIII-2. Summary of Costs for Implemantation and Operation

One significant cost of the CBE System which is expected to shift after the implementation period is the cost of courseware. Initially, most courseware should be imported. That is, the initial courseware, for the most part, should be computer based instructional modules which has been developed and validated at other institutions. The approach of importing courseware is much more expeditious and less expensive than developing materials at DMACC. The implementation plan reflects this philosophy. Inevitably, local development must occur in order to meet the unique instructional needs at DMACC and this is reflected in the projected costs for FY1983.

Another significant cost factor in the plan is the sharing of many costs through participation in WIREC. As long as it remains prudent, costs for courseware and hardware/software will be shared through the Consortium arrangement.

Benefits. The benefits which we anticipate will be derived from the System are of several types. The most significant benefit is the improved quality of instruction which will be accounted for in the number of graduates who, because of CBE, are able to enter and contribute an additional measure to society and their personal career. The CBE System provides a number of less quantifiable benefits such as:

* an alternate delivery system;
* a flexible learning resource;
* the continual availability of an instructional resource;

* better use of professionals' time;
* more accurate comprehensive learning center records;
* enhanced staff and student computer literacy;
* increased statistical research capability;
* new perspectives in teaching;
* occupational simulation;
* increased institutional communication;
* increased productivity; and,
* reduced student attrition.

One of the benefits that is somewhat quantifiable is the retention of students because of timely remedial or compensatory instruction, especially in the basic skills. Based on our projections by fiscal year 1983 the institution could be realizing an addition to income approaching three-fourths of a million dollars because remediated students were retained in their programs. The net effect of the income from retained students, when compared with the costs of implementing and operating the CBE System are graphically illustrated in Figure VI-1.

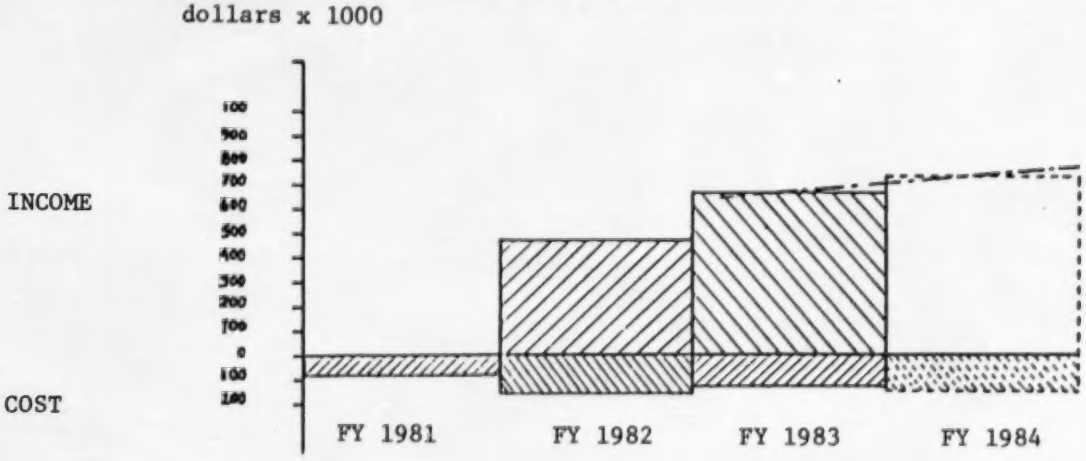


Figure VI-1. Return On Investment

Recommendations

The study team's recommendations fall into two categories. The policy recommendations deal with those issues we see which require internal policy decisions so that the recommended Computer Based Education System will have the best possible environment for success. The action recommendations are those steps we think the college should take to insure that CBE becomes a reality at DMACC.

Obviously, our primary recommendation is that the college should adopt the system for Computer Based Education recommended in this report and move ahead with the implementation plan which we have described. In all, there are 20 other specific policy and action recommendations which support and enhance the primary recommendation.

Conclusion

The Des Moines Area Community College finds itself on the threshold of a new instructional eea. This report marks the initiation of that new instructional era--computer based education. With the implementation of this new instructional technology, the Des Moines Area Community College will be better able to offer instructional services to its constituency and to better insure that its students successfully accomplish their college goals.

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